

Appendix 5.10-A

Visual Simulation Methodology by EDR

Visual Simulation Methodology

Cape Wind Project

**Cape Cod, Martha's Vineyard and Nantucket
Massachusetts**

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INTRODUCTION

This report describes the methodology used to prepare visual simulations of the proposed Cape Wind Project.

Project Description

The proposed Cape Wind Project is a 454 MW offshore wind-powered electric generating facility, with associated offshore and onshore transmission lines. As currently proposed, the project includes 130 3.6 MW General Electric (GE) offshore wind turbines, each mounted on 246 foot/75 meter-tall tubular steel monopole towers. The 3-bladed rotors have a diameter of approximately 341 feet/104 meters and will reach a maximum height of approximately 417 feet/127 meters above sea level. Each tower has a service platform located approximately 30 feet/10 meters above the water surface. For the purposes of this study it was assumed that every other wind turbine on the project perimeter would be illuminated with dual aviation warning lights (white strobes [FAA L865] during the day and flashing medium intensity red lights [FAA L864] at night) mounted on the nacelle. The remaining perimeter turbines would be marked day and night with two flashing low intensity red lights (FAA L810). Interior turbines would each have two flashing low intensity red lights (L810) at night and during the day time. Coast Guard amber navigation warning lights will be installed on each tower approximately 35 feet above the water's surface. The turbines are arranged in a grid pattern with an approximate separation distance of 0.3 to 0.5 mile (Figure 1).

Other visible components of the project include a 197 foot-tall meteorological (met.) tower (already installed) and an electrical service platform. The met. tower is a monopole with a tubular steel tripod base and a 20 x 26 foot service platform. It is topped with an FAA aviation warning light. The electrical service platform is an enclosed structure, 100 feet tall, by 200 feet wide, by 100 feet long which houses transformers and electrical switching equipment. It is sided with metal panels and supported by cross-braced tubular steel legs, approximately 40 feet above the water surface. No FAA lights are required on the electric service platform; Coast Guard lighting will be installed as described above. Helicopter warning lights will be remotely activated on the helipad as needed. All built components of the facility are proposed to be painted a marine gray color.

Project Site

The proposed project site is on Horseshoe Shoals in Nantucket Sound off the coast of Massachusetts. The project is located in U.S. Waters, and covers a total area of approximately 24 square miles. Water depth in this area ranges from 6 to 50 feet. The nearest project components are located approximately 4.7 miles from Cape Cod (Point Gammon), 5.4 miles from Martha's Vineyard (Cape Poge), and 11.2 miles from Nantucket (Great Point), Massachusetts.

Viewpoint Selection

In accordance with guidance provided by the U.S. Army Corps of Engineers (USACE) and Massachusetts Environmental Protection Agency (MEPA) it was decided that visual simulations of the visible components of the proposed wind park would be prepared from representative designated historic properties and districts on Cape Cod, Nantucket and Martha's Vineyard, to help assess potential overall visual impact of the project.

Known historic properties in communities within potential visual range of the offshore turbines were identified by the project's cultural resource consultant (PAL, Inc.), based upon

a review of records at the Massachusetts Historical Commission (MHC). The communities included the Towns of Barnstable, Falmouth, Yarmouth, Dennis, Harwich, Chatham, Nantucket and Martha's Vineyard. The historic properties included historic districts and individual properties that have been listed or determined eligible for listing in the National Register of Historic Places, as well as properties that have been locally designated and are included in MHC's *Inventory of Historic and Archaeological Assets of the Commonwealth*.

A total of 18 historic properties and districts along the south side of Cape Cod from Woods Hole to Chatham were visited and photo-documented by ESS Group staff on October 28, 2002, to determine whether open views toward the proposed wind park were available from the identified historic resource. Due to the generally level topography, mature wooded vegetation and intervening structures, open ground-level views toward the wind park were generally limited to areas in the immediate vicinity of the shoreline.

Following the field visits, a total of six representative locations on Cape Cod with open unobstructed views toward the wind park were recommended to USACE, MEPA and MHC for visual simulations. Three locations each on Nantucket and Martha's Vineyard with open unobstructed views were also recommended. Locations were selected to obtain the most open publicly available view toward the wind park at each viewpoint, based upon field observations. Within historic districts, representative locations were selected to obtain unobstructed publicly available views relative to other areas of the district, in accordance with the MEPA Environmental Notification Form (ENF) Certificate. In cases where the historic district extended to the waterfront, shoreline locations were recommended for simulations. The 12 locations are listed in Table 1 and shown on Figure 2.

The USACE and MHC concurred that preparation of simulations from these 12 viewpoints would adequately illustrate project visibility and visual impact from Cape Cod, Nantucket and Martha's Vineyard.

Table 1. Proposed Visual Simulation Locations.

Location	Village Town	View-point	MHC No.	Distance/Direction to Wind Park	Comments
Cape Cod					
Nobska Lighthouse	Woods Hole Falmouth	VP 1	FAL.LH S/NRHP	14.1 miles ESE	Elevated
Cotuit Historic District	Cotuit Barnstable	VP 5	BRNK.HD S/NRHP	6.1 miles SE	Shorefront
Wianno Club & Wianno Historic District	Osterville Barnstable	VP 6	BRN.769 BRN.J S/NRHP	5.7 miles SSE	Shorefront
Craigville Area	Craigville Barnstable	VP 7	BRN.I S/NRHP	7.0 miles SSE	Elevated
Kennedy Compound & Hyannis Port Historic District	Hyannis Port Barnstable	VP 8	BRN.AJ NHL BRN.E S/NRHP	6.2 miles S	Shorefront
Monomoy Lighthouse	Chatham	VP 26	CHA.LS CHA.927 S/NRHP	14.9 miles WSW	Shorefront

Martha's Vineyard						
Tucker Cottage, Ocean Park		Oak Bluffs	VP 21	OAK.E S/NRHP	9.4 miles ENE	Representative View
Village Historic District; Local Historic District		Edgartown	VP 20	EDG.A S/NRHP EDG.B Local	8.8 miles NE	Representative View
Cape Poge Lighthouse		Edgartown	VP 19	EDG.900	5.4 miles NE	Representative View
Nantucket						
Nantucket District	Historic	Nantucket	VP 24	S/NRHP NHL	11.1 miles N	Tuckernuck Island
Nantucket District	Historic	Nantucket	VP 22	S/NRHP NHL	13.6 miles NNW	Cliffs Near Town
Nantucket District	Historic	Nantucket	VP 23	S/NRHP NHL	11.2 miles NW	Great Point

Abbreviations:

S/NRHP: Listed or eligible for listing on the State and National Registers of Historic Places

NHL: National Historic Landmark

Local: Locally designated historic property or district

METHODOLOGY

Computer Model

To develop a computer model of the proposed offshore wind park, Environmental Design & Research, P.C. (EDR) obtained a layout plan from Cape Wind Associates and turbine and tower specifications and dimensions from GE Wind Energy. Drawings of the proposed electrical service platform were also provided by Cape Wind. This data was used to construct to-scale computer models of the individual project components and the 130 turbine array proposed by Cape Wind (Figure 3). All visible facilities were modeled to scale and in the proper geographic location and elevation using 3D Studio Max 5.0® software. Appropriate structural materials and finishes were applied based on information provided by Cape Wind.

Viewpoint Photos

Field Work Methodology

Day time and night time field photos were obtained from each of the 12 selected shoreline viewpoints during the winter and spring of 2003. On each trip, a two-person crew (one photographer and one surveyor) visited one or more of the selected viewpoints. At each viewpoint a camera and tripod were set up and the exact location of the camera determined using GPS survey equipment (accurate to approximately 1.0 cm). The locations of other known features in the area (bench marks, not necessarily visible in the photograph) were also determined to assure the accuracy of the surveyed camera location relative to other features of the landscape. The exact location of the center point of the proposed wind park (based on layout plans and coordinates provided by Cape Wind Associates, and the location of the built met. tower) was used to determine the appropriate bearing for the camera, so that the proposed project site was generally centered in the field of view of each photograph

(although in some instances obstructions or points of interest [Monomoy Lighthouse] resulted in minor shifts). At each viewpoint, this bearing was established by the surveyor and verified with a hand-held GPS unit and a compass (and/or by observing the met. tower, if visible).

Once the line of sight was determined, EDR's surveyor noted the precise location of existing foreground reference points that were visible in the field of view (e.g. buildings, flag poles, lifeguard chairs). Where adequate reference points were lacking, stakes were placed within each view and their location verified by survey.

Photos were taken with a Nikon D100 digital camera with a focal length of approximately 33 mm (equivalent to a 50 mm lens on a 35 mm film camera) to simulate normal human eyesight relative to scale. Photos were also taken with a 35 mm Canon EOS camera with a 50 mm lens, as back up. Where panoramic views were available, a wide angle photo, or a series of sequential 50 mm photos, were also taken to capture the entire view. The time and location of each photo was documented on all electronic equipment (cameras, GPS units, etc.) and noted on field maps and data sheets.

Night time photos were obtained in the same manner described above. The EDR crew returned to each viewpoint after dark and reset the camera and tripod in the location used to obtain the day time photos. Survey data on the location of the camera and reference points thus did not need to be recollected. However, a directional marker (a flash light or the illuminated met. tower) was used to reestablish the appropriate line of sight for the night time photos. Night time photos were obtained using digital and film cameras. With the latter, a range of shutter speeds (1 second to 5 minutes) was used at each viewpoint.

At each of the viewpoints visited, EDR also documented the availability of other open views toward the project site. Other than on Nantucket (which is located entirely within a historic district), this generally involved walking and driving within a one mile radius of the selected viewpoint location or the boundaries of the historic district (which ever was smaller) to determine if the selected viewpoint offered the most open view available. Other views and the type and extent of screening were documented. Photos and field notes were also used to document the overall aesthetic character of the area or historic district, including both built and natural features.

Field Work Results

EDR conducted five site visits to the Cape and Islands between the dates of January 20th and June 10, 2003, to obtain the viewpoint photos. A trip to Cape Cod was conducted between January 20 and January 23. Martha's Vineyard was visited between February 5 and February 6, and Nantucket was visited on March 19 and again on May 19-20. The 12 locations, which were approved by the USACE, were visited, photographed and surveyed by EDR. These locations and information regarding photo location, time of day and weather conditions are presented in Table 2 below:

Table 2. Viewpoint Data.

Viewpoint #	Historic Property/District	Date	Time	Elevation*	Location	Weather (temp. in F)
Cape Cod						
1	Nobska Lighthouse Town of Falmouth	1/22/03	11:53 a.m. 6:15 p.m.	50.7'	Nobska Road, Woods Hole	Windy, 18°, clear/some haze but limited to areas around islands.

Viewpoint #	Historic Property/District	Date	Time	Elevation*	Location	Weather (temp. in F)
5	Cotuit Historic District Town of Barnstable	1/22/03	1:47 p.m. 7:15 p.m.	4.8'	Ocean View Avenue, Cotuit Highlands	Windy, 19°, clear, partly cloudy on horizon, light haze
6	Wianno Area Town of Barnstable	1/22/03	3:30 p.m. 4:28 p.m. 9:45 p.m.	22.5'	Sea View Avenue, Wianno	Windy, 20°, low cloud cover on horizon, blue sky, strong low light
7	Craigville Area Town of Barnstable	1/21/03	1:10 p.m. 4:45 p.m. 9:00 p.m.	29.5'	#6 Butler Avenue	Cold, windy, partly clear and some haze on horizon
8	Hyannis Port Historic District Town of Barnstable	1/21/03	11:12 a.m. 4:30 p.m. 10:00 p.m.	19.3'	Scudder and Dale Avenue	Windy, 10°, low cloud cover on horizon, bright sun
26	Monomoy Lighthouse Town of Chatham	6/10/03	10:12 a.m.	30.0'	Bluffs near light house	Calm, 70°, haze on horizon
Martha's Vineyard						
VP 21	Tucker Cottage, Ocean Park	2/6/03	3:03 p.m. 6:42 p.m.	49.0'	Ocean and Sea View Avenues	Clear, Cold
VP 20	Village Historic Districts, Edgartown	2/6/03	10:49 a.m. 8:20 p.m.	30.6'	Lighthouse Beach near Water Street	Clear, Cold
VP 19	Cape Poge Lighthouse	2/5/03	2:14 p.m. 6:29 p.m.	51.6'	North Chappaquiddick Island	Clear, 34°
Nantucket						
VP 24	Nantucket Historic District	5/20/03	7:27 p.m. 7:57 p.m.	24.0	Tuckernuck Island	Partly cloudy, clearing fog, 55°
VP 22	Nantucket Historic District	3/19/03	11:01 a.m. 8:56 p.m.	39.5'	Cliff Road	Clear, scattered clouds, 36°
VP 23	Nantucket Historic District	3/19/03	2:55 p.m. 7:13 p.m.	13.5'	Great Point Lighthouse	Clear, scattered clouds, 35°

* NAVD88. Camera height is approximately 5 feet above ground surface.

Field visits were scheduled based on forecasts of clear sky conditions, and offshore visibility to the proposed project site was clear in all cases. As Table 2 illustrates, photos were obtained at a variety of times during the day to accurately illustrate the range of views that will be available. However, midday and afternoon photos were obtained from most of the viewpoints, as sun location and low clouds hindered visibility during the morning hours. Shoreline views and those more interior within the historic districts were included, although in most places, open views toward the project site diminish quickly as one moves inland.

In accordance with the project scoping requirements, the selected viewpoints were the most open, unobstructed, publicly-accessible views toward the project site at each historic property and within each historic district. The selected viewpoint at Cotuit was from Loop Beach, just south of and outside the historic district's boundary, because no unobstructed, publicly-accessible views were available within the district itself. However, because open private views were available and because future loss of trees could create open public views within the district, an open shoreline view immediately adjacent to the district was selected to provide a representative view.

In addition to the selected viewpoints, character photos, along with photos documenting existing screening, were also obtained from various locations within the vicinity of each viewpoint or within each district (see Figures 5.10-2, sheets 1-64 in Section 5.10 of the DEIR/DEIS).

Night time photographs were obtained from most of these locations, including undeveloped shoreline sites such as Great Point on Nantucket and Cape Poge on Martha's Vineyard. Because the character of such sites is similar to that of Monomoy, Cape Wind requested and received relief from USACE from obtaining a night time image from Monomoy Island. As a result of its designation as a National Wildlife Refuge, public access to the island is restricted by the U.S. Fish and Wildlife Service during the evening hours. Therefore, potential night time viewers of the turbines are not anticipated at Monomoy. In addition, night time access to this remote area is difficult and potentially dangerous, especially during winter conditions. Because 11 other night time simulations are being prepared, the USACE agreed that representative night time impacts of the wind park are adequately represented and a night time simulation from Monomoy Island would not be necessary.

Visual Simulations

To show anticipated visual changes associated with the proposed project, high-resolution computer-enhanced image processing was used to create realistic photographic simulations of the completed Cape Wind offshore wind park from each of the selected viewpoints. Simulations were developed by adding three-dimensional computer models of the proposed 130 turbine facility to photos from each of the 12 selected viewpoints. The first step in this process involved translating survey data collected in the field into an AutoCAD 2000® drawing. The proposed layout plan for the wind park was also incorporated into the AutoCAD drawing in a common datum (Massachusetts State Plane). The two dimensional AutoCAD data was then imported into 3D Studio Max 5.0® and three-dimensional components (cameras, modeled turbines, lights, etc.) were added. This data was superimposed over photographs from each of the viewpoints, and minor camera changes (height, roll, precise lens setting) made to align all known reference points within the view. This process ensured that project elements were shown in proportion, perspective, and proper relation to the existing landscape elements in the view. Consequently, the alignment, elevations, dimensions and locations of the proposed wind turbines are accurate and true to the proposed design.

At this point, a “wire frame” model of the facility and reference points is shown on each of the photographs (see Figure 4). Various studies and data sources were consulted, and calculations performed to determine the effect curvature of the earth would have on turbine visibility. This effort resulted in the determination that the visible horizon is approximately 3-4 miles from a viewer standing at sea level. However, variables associated with light refraction, wave height and the effect of atmospheric conditions make it impossible to determine exactly how much of each turbine will fall below the visible horizon line. EDR’s research, coupled with our evaluation of the visibility of the constructed met. tower, led us to the conclusion that curvature of the earth would obscure the bases of all the turbines from all of the selected viewpoints, with possible exception of Cape Poge. (Due to the height of this viewpoint and its distance from the project site, one calculation suggested that some of the turbines would fall in front of the visible horizon). However, because the extent of screening could not be accurately determined, the simulations were created by placing the project on the visible horizon. Using the constructed met tower as a locational and scale reference in the photos demonstrated the accuracy of this approach (i.e. the modeled met. tower overlaid the actual met. tower very closely - see Figure 4).

The proposed exterior color/finish of the wind turbines was then added to the model and the software simulated the appropriate sun angle based on the specific date, time and location (latitude and longitude) at which each photo was taken. This information allowed the computer to accurately illustrate highlights, shading and shadows for each individual turbine shown in the view. The effects of distance (hazing, bluing, loss of detail) were not added to these simulations due to clear sky conditions present at the time the photos were taken. In addition, illuminated white aviation warning lights were not shown in the simulations, because in EDR’s experience, these lights are not visible/noticeable under clear day time conditions. The day time simulations of the proposed project are presented as Figure 5.10-3 (sheets 1-12) in Section 5.10 of the DEIR/DEIS.

Data on the proposed lighting system was provided by ESS to assist with preparation of the night time simulations. In addition, night time field notes and photos of the constructed met. tower were obtained from various night time viewpoints on Cape Cod and Martha’s Vineyard. Night time simulations were prepared using the night time photos obtained at each viewpoint (except Monomoy). To simulate the appearance of the proposed FAA warning lights, night time photos of the constructed meteorological tower (which includes an L810 light fixture) and the constructed Fenner (New York) Wind Power Project (which includes L810 and L864 lights on the turbines) were obtained under clear sky conditions. Photos were obtained at distances ranging from 1 to 16 miles. The lights as they appeared in these photos were then added to the computer model of the Cape Wind Project and aligned to the night time photos in the same manner as described for the day time simulations. Because size, color and intensity of the lights appear to vary with distance, light images from similar distances were added to the simulations (i.e. photos of the Fenner project from 5-10 miles away were used to simulate lighting on Cape Wind turbines located 5-10 miles from the viewer). A full set of simulated night time photos of the Cape Wind project were prepared in this manner.

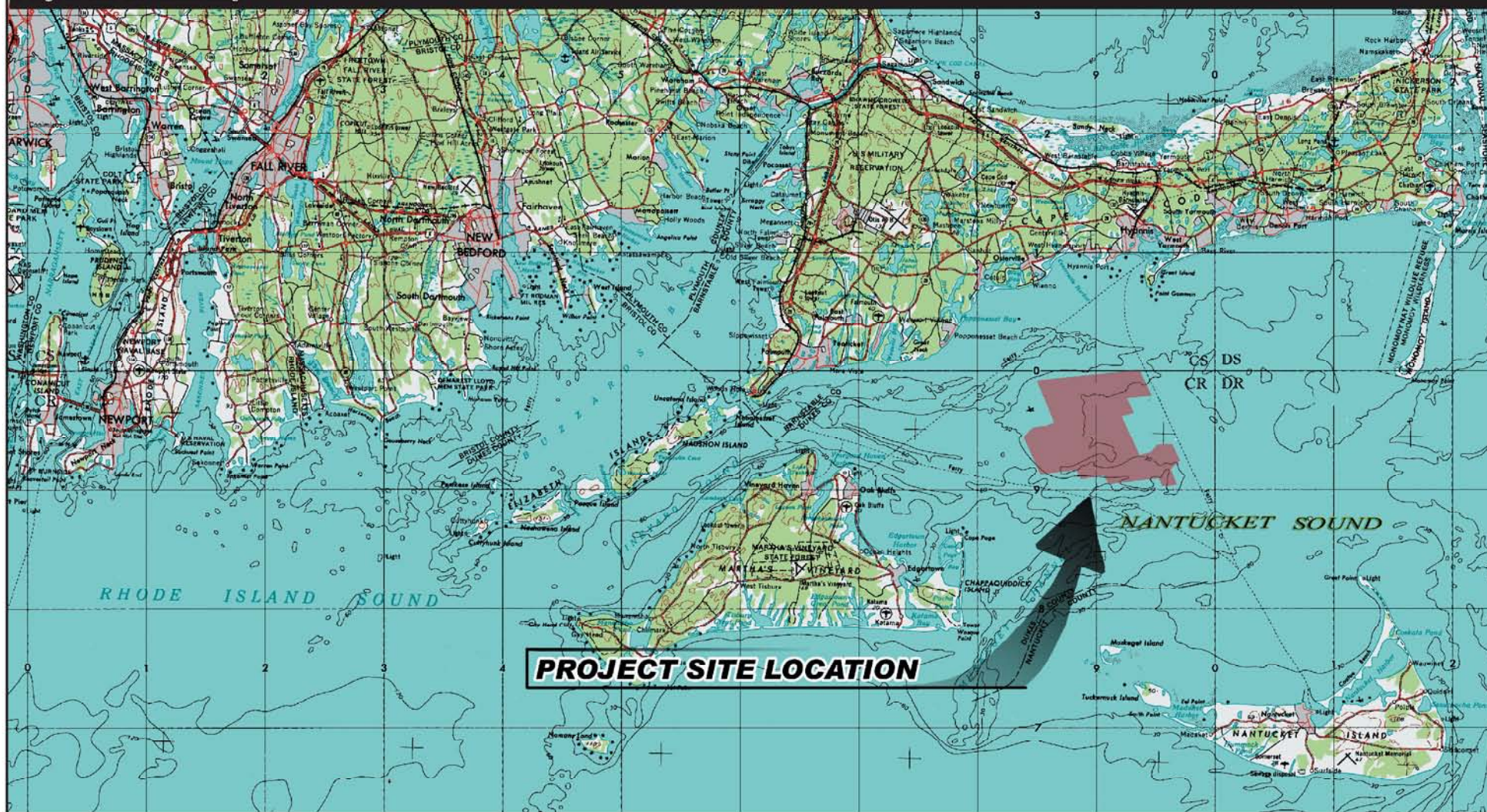
Upon reviewing the night time simulations described above, it was determined that while they accurately portrayed how a night time photo of the proposed project would appear, they did not accurately illustrate what observers actually saw when viewing such lights in the field. This seemed to be related to the fact that relatively long exposures are necessary to photograph night time images. These long exposure times allow lights within the photo to become overexposed. For example the simulated photos often showed the lights with a white center and a glowing “halo” around the outside edge. However, individuals who observed such lights in the field reported seeing a fairly sharp pinpoint of pure red light.

To show a simulation of what the project would actually look like to the human eye, several variations of the original simulations were prepared. These were then taken into the field with a group of observers to compare them with actual views of the Fenner Wind Power Project. On August 20, 2003, three individuals (2 EDR staff members and an outside participant) observed the Fenner Project from distances ranging from 10 to 13 miles. This project occurs in a sparsely settled, rural/agricultural area of central New York State with very little ambient lighting. Conditions at the time of field observation were characterized by clear skies, calm winds, low relative humidity and temperatures in the range of 70°-75°F. The lights on the Fenner turbines were clearly visible and the L810 and L864 lights could be easily distinguished. In comparing the actual views to the photographic simulations, the observers made the following observations

- Light intensity in the simulations needed to be increased
- Light color needed to be a deeper shade of red
- Lights should appear as clear, sharp points
- Little or no halo effect should be shown
- White centers should not be shown on the lights

Based on these observations, the night time simulations of the Cape Wind Project were revised until the observers concurred with their appearance. Changes to the original simulations involved all of the changes recommended by the observers, particularly sharpening the edges and adjusting the color of the lights. These changes are reflected in the final set of night time simulations presented as Figure 5.10.4 (sheets 1-11) in Section 5.0 in the DEIR/DEIS. Because the FAA warning lights will be flashing, the proposed flashing rate (20 FPM) was used to animate the simulations, with each interior turbine flashing randomly (rather than synchronized). Each simulation is essentially a snap shot that shows the project at one moment in time (i.e. 1/30th of a second) with some portion (in the range of 50-65%) of the interior lights on. All of the perimeter lights are illuminated, as the flashing of these lights is proposed to be synchronized. No visible lighting from the Coast Guard navigation warning lights was shown in the night time simulations, as the proposed lights have a range of approximately 2 nautical miles, and the nearest shoreline viewpoint is approximately 5.4 miles from the nearest proposed tower.

Project Site Location Map



Prepared for:

Cape Wind
Energy for Life

ESS
Lifound Inc.

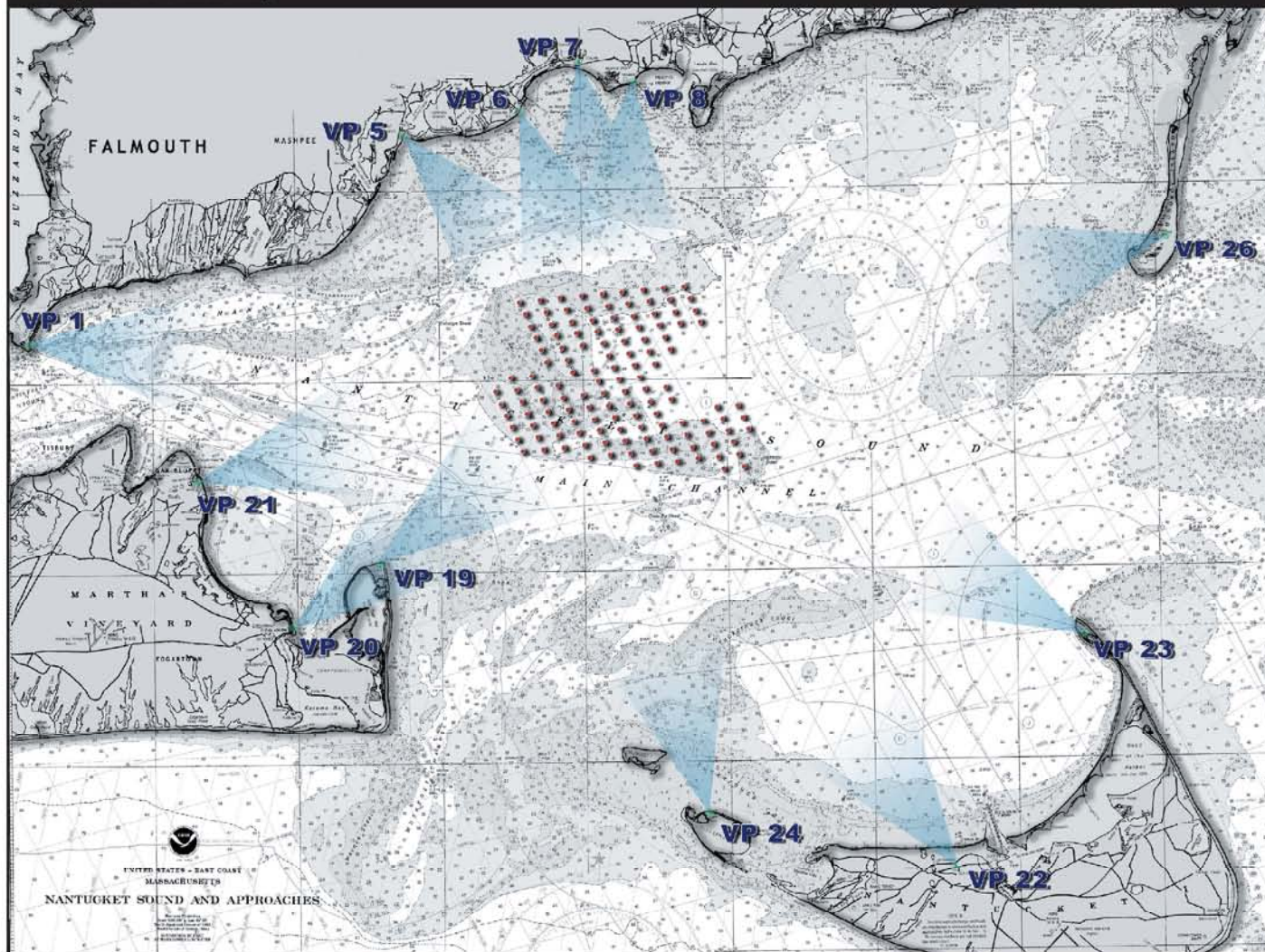
Prepared by:

EDR Inc.

Figure 1

Proposed Project Site Location Map

Viewpoint Location Map



Viewpoint Photo and Description

- | | |
|--|------------------------------------|
| | - 1 Nobska Lighthouse, Falmouth |
| | - 5 Cotuit, Barnstable |
| | - 6 Wianno, Barnstable |
| | - 7 Craigville, Barnstable |
| | - 8 Hyannis, Barnstable |
| | - 19 Cape Poge, Martha's Vineyard |
| | - 20 Edgartown, Martha's Vineyard |
| | - 21 Oak Bluffs, Martha's Vineyard |
| | - 22 Nantucket Village |
| | - 23 Great Point, Nantucket |
| | - 24 Tuckernuck Island, Nantucket |
| | - 26 Monomoy Point, Chatham |

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Cape Wind
Energy for Life

ESS
Terracon Inc.

Prepared by:

EDR Inc.

Figure 2

Viewpoint Location Map

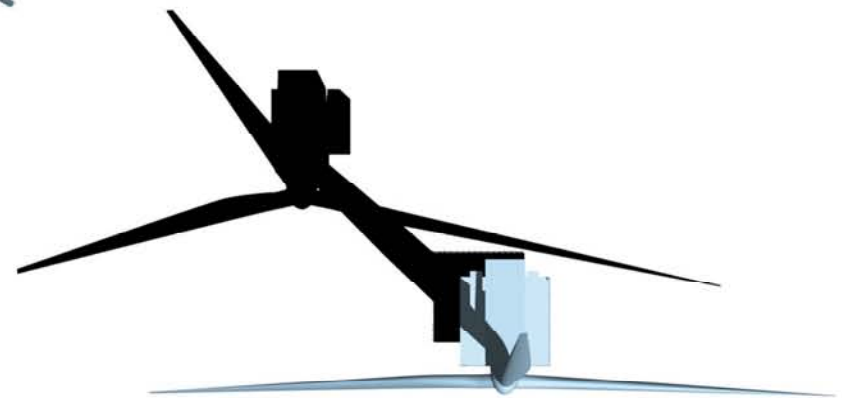
Three Dimesional Computer Model



Side Elevation



Front Elevation



Plan

Proposed Color of Turbine	Blue Gray (R=77 G=194 B=215)
Height to Hub	240'
Hub Diameter	13.3'
Bounding Dimensions of Nacel (LxWxH)	48' X 40' X 27'
Maximum Width of Tower	16' dia
Minimum Width of Tower	11' dia
Rotor Diameter	341'
Maximum Rotor Blade Width	12'
Maximum Height above Sea Level	417'
Wind Direction	SW
Height of Turbine Platform above Sea Level	30'
Bounding Dim. of ESP (LxWxH)	100' X 200' X 100'
Aviation Warning Lights	FAA L864/L865 L810
Coast Guard Warning Lights	Dual Amber USCG Lights

Prepared for:

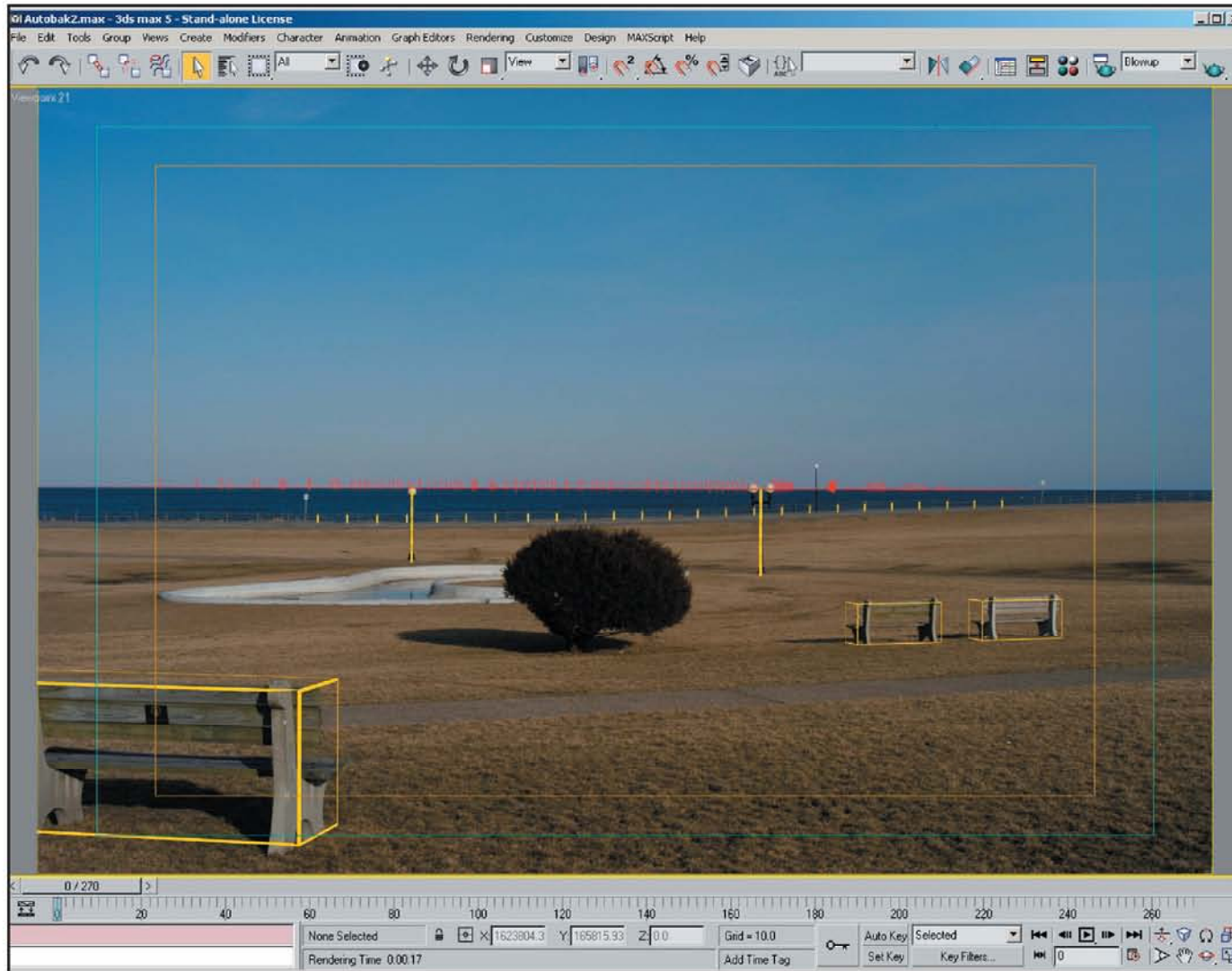


Figure 3

Computer Model of Proposed 3.6 MW Wind Turbine

Prepared by:





The Visual Simulation Process

At each viewpoint a camera and tripod were set up and the exact location of the camera was determined using survey equipment.

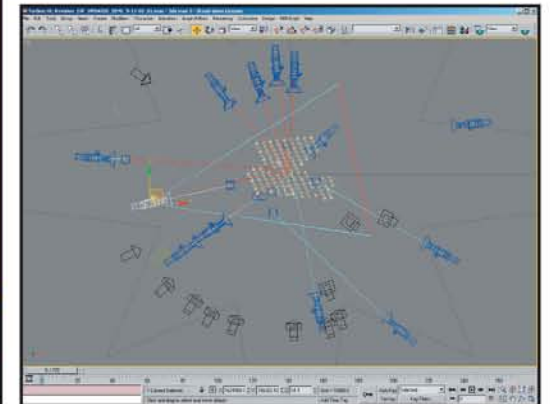


The location of the proposed wind park was determined based on plans provided by the project developer, and these coordinates were used to determine the appropriate bearing for the photograph.

Once the camera angle was set we also surveyed the exact location of existing foreground reference points or stakes that were placed in each viewpoint for alignment verification.

This information is translated to AutoCAD 2000® and then to 3D Studio MAX 5.0®.

Screen Views of a Working Model



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Cape Wind
Energy for Life.

ESS
Group Inc.

Prepared by:

EDR

Figure 4

Working Model - Screen Images